that of Fig. 2, which shows a section of cow-hide tanned with oak-bark and curried with *dégras*.

Before describing Fig. 2, it is necessary to explain the mode of preparation of the section. A small strip of leather about 10 mm. wide is taken, and the flesh side shaved away until the piece has a thickness of about 2 mm. The shaved strip is placed in melted tallow, not too hot, for about a quarter of an hour; after cooling, the strip is embedded in hard paraffin and cut in a Ranvier microtome, the sections degreased with xylol, then washed two or three times with alcohol, and stained with Weigert's fuchsin; the staining takes about three hours; the Weigert solution is poured off, and a few drops of absolute alcohol put on to the section; this removes excess of dye, and differentiates the various parts. It is now washed twice with alcohol, passed two or three times through xylol to eliminate the alcohol, and finally mounted in balsam.

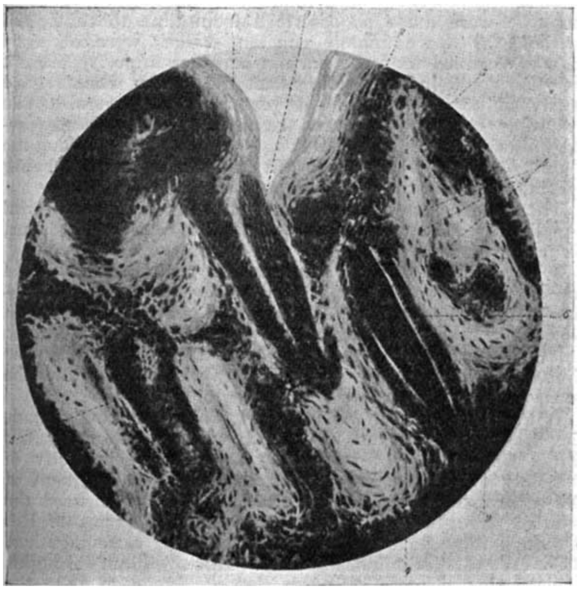

FIG. 1.

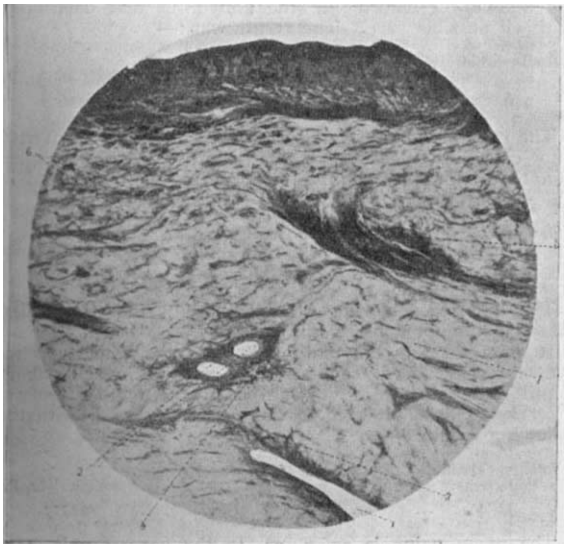

FIG. 2.

In M. Boulanger's view, the skin, when freed from the hair and the histological epidermis (both of which are got rid of in the preparatory processes), is composed of two tissues, an upper and a lower, intimately united, although of distinctly different natures. No scientific designation has been given to these two distinct layers, but the whole has been called the dermis; in view of their special constitution, and to distinguish them, he calls the "grain" the fibro-elastic layer and the "flesh" the layer of giant connective fibres. The elastic fibres in their natural state take up Weigert's stain readily, and they retain this property after tanning; both before and after the tannage they form the essential framework of the skin or leather; without them there is no elasticity or suppleness, and tanning does not appear to alter their constitution. The connective fibres, on the contrary, are completely changed, so that we may conclude that the tannin acts differently on the two tissues.

The present writer will not here discuss this conclusion, though in his opinion there is no such distinct difference between the two portions of the skin, but that in the "grain" the connective tissue is fine and closely compacted, whereas in the "flesh" it becomes loose and coarse; thus the difference is in degree, and not in constitution. Boulanger's fibro-elastic layer must not be confounded with the elastic yellow fibres which form a comparatively small part of the volume of the skin. Comparing the two figures, there is a striking contrast in the general setting of the elastic fibres. In the raw skin they ramify in all directions, whereas in the tanned skin they only exist in a longitudinal direction, as a consequence of the dilation and preparation that the skin has undergone.

M. Boulanger has utilised his method in the study of leather for use as belts, &c., the results of which are published in his book, "Essais du Cuir dans ses Applications industrielles." There is no doubt that the method of microscopic examination of leather might be of considerable use after much practice in the manipulation and comparison of various leathers has been acquired. It would then be possible to determine whether the leather under examination had been made from a salted skin or a fresh skin, of European origin, or from a foreign dried skin, the sex of the animal, cow, ox, or bull; whether the leather had been adulterated, overloaded with tannin or weighting materials, &c., in short, the history of the pelt might be deduced from the study of the tanned leather. Let us hope that the younger generation of tanning students now being trained in the leather industries department at the University of Leeds and at Herold's Institute in Bermondsey will keep up the reputation of England in this work.

J. T. W.

THE ATOMIC WEIGHT OF RADIUM.[1]

ALTHOUGH there has been a considerable amount of discussion, based upon spectroscopic considerations and on its supposed mode of genesis, respecting the place of radium in the system of the elements, and inferentially, therefore, concerning its atomic weight, we are indebted for the only direct experimental determinations of this value hitherto made known to the discoverer of the element, Mme. Curie. Her first observations, published in 1902, were made on about 90 milligrams of the chloride, and furnished the value 225.

In the autumn of last year Mme. Curie communicated to the French Academy the results of a second series of estimations made upon about 4 decigrams of the carefully purified chloride; these afforded the value 226·2 as the mean of three closely concordant determinations ($Ag=107{\cdot}8$, $Cl=35{\cdot}4$).

In 1906, at the instance of Sir William Huggins, then president of the Royal Society, and by the aid of the kind interest shown by H.R.H. the Prince of Wales, the Austrian Government placed about 500 kilograms of pitchblende residues from Joachimsthal at the disposal of the Royal Society. These residues were worked up by M.

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[1] Bakerian Lecture for 1907. Delivered at the Royal Society by Dr. T. E. Thorpe, C.B., F.R.S.

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Armet de Lisle at Nogent-sur-Marne. The funds were defrayed from a grant made by the Goldsmiths' Company to the Royal Society, in 1904, for the purpose of the investigation of radium.

The process of extraction produced about 413 grams of anhydrous barium chloride, containing radium chloride sufficient to give the salt a radio-activity 560 times that of uranium.

This salt was received by the Royal Society in the autumn of 1906, and was handed to me in January, 1907, with the request that I would extract the radium chloride from it, and undertake, if possible, a re-determination of the atomic weight of the element.

The method of extraction was substantially that adopted by Mme. Curie, namely, systematic fractional crystallisation, first from water and then from increasingly strong hydrochloric acid, until finally the acid used was the strongest that could be obtained by distillation.

Whilst still engaged in the isolation of the radium chloride from the material furnished by M. Armet de Lisle, I received a further small supply of radium from the Royal Society. It was bought in Cambridge, and purported to be radium bromide, but on removing it from the capsule, in which it had been stored since 1903, it was found to be wholly insoluble in water. On treatment with pure dilute hydrobromic acid it readily passed into solution. The salt obtained by evaporation was sent to Prof. Rutherford, who had kindly undertaken to make any measurements of radio-activity which I needed. He estimated the amount of radium present as equivalent to 33 milligrams of radium bromide. This salt was eventually converted into chloride, and was purified by repeated crystallisation from strong hydrochloric acid.

Determination of Atomic Weight.—This was effected by ascertaining the amount of silver chloride yielded by a weighed quantity of the anhydrous radium chloride—the principle of the method already employed by Mme. Curie.

A method was devised whereby the whole of the operations of drying and weighing the radium chloride, precipitating, washing, drying, and weighing the silver chloride, might be performed in one and the same vessel, thus obviating the necessity of transferring the silver salt and of separating it by any of the ordinary processes of filtration.

The vessel in which these operations were made consisted of a thin glass tube with a conical base furnished with a hollow, well-ground stopper. It had a capacity of about 15 c.c., and was as light as was consistent with the requisite strength, and could be suspended from the balance-arm by fine platinum wire. In all the weighings a precisely similar bottle of almost identical weight and capacity, suspended in like manner, was employed as a tare. The weighings were made on a very sensitive assay balance, with 4-inch arms, carrying a maximum load of 12 grams, and provided with light stirrup pans.

The washed silver chloride was first dried at 100°, and then heated in the air bath to 160° for about a couple of hours, and, after standing in the desiccator over phosphoric oxide for about eighteen hours, was weighed in the manner described.

In order to test the practicability of the method and to acquire experience of its working, as well as to gain some idea of its accuracy before actually making use of it in the case of the radium salt, a series of determinations of atomic weight of barium was made with purified barium chloride.

The results were as follows:—

Ag = 107·93. Cl = 35·45.

Barium chloride, milligrams	Silver chloride, milligrams	Atomic weight, Ba
114·7	157·8	137·5
172·1	236·8	137·5
57·1	78·8	136·9
62·6	86·1	137·6
68·1	93·7	137·5

The value for barium adopted by the International Committee on Atomic Weights, 1907–8, is 137·4.

It will be seen from these numbers that a close approximation to the true atomic weight of barium can be obtained by the method described, the maximum error being about half a unit, or less than 0·5 per cent. Considering that the atomic weight of radium is probably nearly double that of barium, the same fortuitous errors would affect its value to about a unit.

As the work of isolating and purifying the radium chloride proceeded, determinations of the amount of chlorine were made as described from time to time, and as soon as approximately constant values were obtained it was assumed that any barium or other impurity present was too small in amount to affect the results when regard was had to the unavoidable experimental errors. The resulting chloride was then repeatedly and carefully re-crystallised from pure, strong hydrochloric acid, the "tails," which were comparatively rich in radium, being specially set apart.

The purified salt finally extracted from the material supplied by M. Armet de Lisle weighed, when anhydrous, 64 milligrams.

I regard this salt as substantially radium chloride. I am not, however, in a position to say that it was absolutely free from barium. At the same time, I have reason to believe that the amount still present was probably too small materially to influence the result, considering the limited quantity of the salt I had to work with, and the consequent relatively large experimental errors.

With the aid of Sir William Huggins, who kindly made the spectroscopic trials for me, I was able to carry out Mme. Curie's test of comparing the relative intensity of the lines of barium and radium in the spark spectrum of the separated radium chloride. Mme. Curie compared the relative strengths of lines 4554·2 of Ba and 4533·3 of Rd. Although these have the advantage of being close together, they are of dissimilar intensity. Sir William Huggins advised that a more stringent test would be to take the line 5536·2 of Ba of intensity 10, and compare it with the Rd lines 5813·8 and 5560·8, which are also of intensity 10. On actually making the trials, which were repeated several times, the green Ba line 5536·2, although visible, was seen to be relatively very feeble—less intense, indeed, than that afforded by the most dilute solution of barium chloride we were able to employ.

With this material, therefore, I attempted to make the determination of atomic weight. Accordingly, the greater portion was transferred to the vessel already described, and the amount of chlorine in the anhydrous salt determined with all possible care. The result was:—

Radium chloride, milligrams	Silver chloride, milligrams	Atomic weight, Rd
62·7	60·4	226·8

The radium was recovered from the solution, re-converted into chloride, added to what remained of the original quantity, and the amount of chlorine again determined in the anhydrous salt. The second result was:—

Radium chloride, milligrams	Silver chloride, milligrams	Atomic weight, Rd
63·9	61·8	225·7

The purified chloride obtained from the Cambridge material amounted to 24 milligrams.

It was added to the main bulk, and the whole was repeatedly crystallised from strong hydrochloric acid, about 6 milligrams being thus removed in the mother liquors. After being dried at 150° it was again analysed, with the following results:—

Radium chloride, milligrams	Silver chloride, milligrams	Atomic weight, Rd
78·4	75·3	227·7

The mean value is 226·7, or, to the nearest unit, 227. This, it will be observed, is in very close accord with Mme. Curie's latest number.

I think, therefore, it is reasonably well established that the atomic weight of radium is now known to within a unit which, considering the relatively high number, is, in the present circumstances, as fair a degree of exactitude as could be anticipated.

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